

## TITLE OF THE INVENTION

### THROWAWAY TIP AND THROWAWAY- TYPE CUTTING TOOL

## BACKGROUND OF THE INVENTION

### Field of the invention

The present invention relates to a throwaway tip and a throwaway-type cutting tool , such as an end-mill , to which the throwaway tip is mounted .

The disclosure of Japanese Application No. H11-230916 , 2000-160902 , 2000-180438 is hereby incorporated by reference into the present application .

### Description of the Related Art .

Hitherto , in some throwaway-type end mills in which a plurality of , for example , two , parallelogram plate-like throwaway tips are mounted to the distal end of a tool body , and which are capable of performing a boring operation , one tip has been arranged so that a long cutting edge is defined as a front cutting edge and a short cutting edge is defined as an outer

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peripheral cutting edge, and the other tip has been arranged so that a short cutting edge and a long cutting edge is defined as a front cutting edge and a long cutting edge is defined as an outer peripheral cutting edge .

In this case , if the two tips have the same shape and size , they are conveniently administered or replaced . When such an end mill is used for a shoulder-cutting operation or a drilling operation with the outer peripheral cutting edges provided along the rotation axis of the tool body , for example, when the front cutting edge of one tip is provided so that an outer-peripheral corner-side cutting edge is projected at the distal end to gradually incline inward to a base end , the inner corner cutting edge of the outer tip will project toward the distal end from the outer-peripheral-corner-side cutting edge , so that the front cutting edge is easily chipped at low speed .

In order to overcome such a drawback , when the front cutting edge of the other tip is arranged in a radial direction so as to prevent the inner corner cutting edge from projecting toward the distal end, since the outer peripheral cutting edge of the other tip is inclined inward from the outer peripheral cutting edge of one tip and does not serve as the outer peripheral cutting edge , the outer peripheral cutting edge performs cutting

with a single edge of one tip so that the front cutting edge is easily chipped and cutting efficiency is low .

As an invention for improving such a defect , Japanese Unexamined Patent Application Publication No. 10-291115 discloses an end mill . In the end mill two types of parallelogram plate-like tips are used , which are in line symmetry and are rotated in opposite directions . A short cutting edge of one tip is used as a front cutting edge , and a long cutting edge of the other tip is used as a front cutting edge , thereby adopting an arrangement such that an outer peripheral corner-side cutting edge of each of the front cutting edges is projected toward the distal end from an inner corner cutting edge . This can perform a cutting operation using outer peripheral corner-side cutting edges as two cutting edges , and can improve cutting efficiency by restricting chipping of the outer-peripheral-corner-side cutting edges .

In such a end mill , however , two types of tips having different outer shapes should be prepared , thereby making administration and replacement complicated , running costs increase , and the cost of manufacturing the tip increase .

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In a case where a plurality of such throwaway tips are used and provided at the distal end of a tool body so that the two corner cutting edges on one side are located at the outer periphery of the distal end , if cutting edges on one side sandwiching the corner cutting edges are provided as outer peripheral cutting edges along the rotation axis of the tool body , the



shoulder-cutting operation or a groove -processing operation , a finishing operation can be performed by the corner cutting edges at the outer periphery of the distal end while performing the shoulder- cutting operation by the outer peripheral cutting edges .

#### Brief Description of the Drawings

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings .

Figure 1 ( a ) is a plan view which shows a throwaway tip according to a first embodiment of the present invention .

Figure 1 ( b ) is a side view ,as seen from the direction A in Figure 1 ( a ).

Figure 1 ( c ) is a side view , as seen from the direction B in Figure 1 ( a ) .

Figure 2 is a partial side view of an end mill to which two throwaway tips shown in Figure 1 are mounted .

Figure 3 is a front view of the end mill shown in Figure 2 .

Figure 4 is a side view of the end mill shown in Figure 2 , as seen from the

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direction of an outer peripheral cutting edge .

Figure 5 is a side view of an end mill according to a second embodiment of the present invention .

Figure 6 is a side view of the end mill shown in Figure 5 , a seen from the direction C 1 .

Figure 7 is a side view of the end mill shown in Figure 5 , as seen from the direction D 1 .

Figure 8 ( a ) is a plan view which shows a throwaway tip according to a third embodiment of the present invention .

Figure 8 ( b ) is a side view of a tip shown in Figure 8 ( a ) , as seen from the direction E 1 .

Figure 8 ( c ) is a side view of a tip shown in Figure 8 ( a ) , as seen from the direction F 1 .

Figure 8 ( d ) is a side view of a tip shown in Figure 8 ( a ) , as seen from the direction G 1 .

Figure 9 is a front view of an end mill shown in Figure 8 to which the throwaway tip shown in Figure 8 is mounted .

Figure 10 is a side view of the end mill shown in Figure 8 , as seen from the

direction of one outer peripheral cutting edge .

Figure 11 is a side view of the end mill shown in Figure 8 , as seen from the direction of the other outer peripheral cutting edge .

Figure 12 ( a ) is a front view which shows another example of an end mill to which a throwaway tip is mounted .

Figure 12 ( b ) is a front view which shows another example of an end mill to which a throwaway tip is mounted .

Figure 12 ( c ) is a front view which shows another example of an end mill to which a throwaway tip is mounted .

Figure 12 ( d ) is a front view which shows another example of an end mill to which a throwaway tip is mounted .

Figure 13 ( a ) is a plan view of a throwaway tip according to a modification of the third embodiment .

Figure 13 ( b ) is a side view of a tip shown in Figure 13 ( a ) , as seen from the direction H1 .

Figure 13 ( c ) is a side view of a tip shown in Figure 13 ( a ) , as seen from the direction I 1 .

Figure 13 ( d ) is a side view of a tip shown in Figure 13 ( a ) , as seen from



the direction J 1 .

Figure 13 ( e ) is a side view of a tip shown in Figure 13 ( a ) , as seen from the direction K 1 .

Figure 14 is a plan view which shows a throwaway tip according to an 4 th embodiment of the present invention .

Figure 15 is an side view of an end mill according to an 5 th embodiment of the present invention .

Figure 16 is a plan view of an throwaway tip according to an 5 th embodiment of the present invention .

Figure 17 ( a ) is an line sectional view which shows cross sectioned form of each part of a throwaway tip shown in Figure 16 . .

Figure 17 ( b ) is an M-M line sectional view of Figure 16 .

Figure 18 is a principal part side view of an end mill shown in Figure 16 to which two throwaway tips are mounted .

Figure 19 is a front view of an end mill shown in Figure 18 .

Figure 20 is a side view of the end mill shown in Figure 18 , as seen of the direction of peripheral cutting edge .

Figure 21 is a side view of the end mill according to an 6 th embodiment

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Figure 23 is a side view of an end mill shown in Figure 21 , as seen from the direction of D 2 .

Figure 24 ( b ) is a side view of the tip shown in Figure 24 ( a ) , as seen from the direction of E 2 .

Figure 24 ( c ) is a side view of the tip shown in Figure 24 ( a ) , as seen from the direction of  $F_2$  .

Figure 24 ( d ) is a side view of the tip shown in Figure 24 ( a ) , as seen from the direction of G 2 .

Figure 25 is a front view of an end mill shown in Figure 24 to which the throwaway tip is mounted .

Figure 26 is a side view of an end mill shown in Figure 25 ,as seen from the direction of one outer peripheral cutting edge .

Figure 27 is a side view of an end mill shown in Figure 25 , as seen from





faces 4 gradually inclined outward with a positive inclination angle ( relief angle ) from the lower surface 2 to the upper surface 3 , and is defined as a positive tip . The tip 1 is formed with a bolt-securing insertion hole 5 passing through central portions of the upper surface 3 and the lower surface 2 . The upper surface 3 and the lower surface 2 are formed in substantially the shape of a parallelogram plate . In four ridges of the upper surface 3 , the opposing ridges of each pair are defined as short cutting edges and long cutting edges , one of two cutting edges constituting the short cutting edges is defined as a relatively-long first short cutting edge 6 , and the other cutting edge is defined as a relatively-short second cutting edge 7 . The other two opposing sides constituting the long cutting edges are defined as , for example , a first long cutting edge 8 and a second long cutting edge 9 that are relatively longer than the first short cutting edge 6 . Moreover , the opposing first short cutting edge 6 and the second short cutting edge 7 are not parallel to each other , and the other opposing first and second long cutting edges 8 and 9 are not parallel to each other . The upper surface 3 is defined as a rake face of each of the cutting edges 6 , 7 , 8 , and 9 , and each of the side faces 4 is defined as a relief face .

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A first corner cutting edge 10 and a second corner edge 11 in one diagonal direction of the upper surface 3 are formed by the intersecting first short cutting edge 6 and the first long cutting edge 8 , and the intersecting second short cutting edge 7 and the second long cutting edge 9 , respectively , and each of the corner angles is set to  $90^{\circ}$  or less , preferably , an acute angle , a corner angle of a third corner cutting edge 12 consisting of the first short cutting edge 6 and the second long cutting edge 9 in the other diagonal direction is set to  $90^{\circ}$  , and preferably , an acute angle , and a corner angle of a fourth corner cutting edge 13 consisting of the second short cutting edge 7 and the first long cutting edge 8 is set to an obtuse angle. The corner angles of the first to third corner cutting edges 10 , 11 , and 12 may be either equal or unequal to one another .

The throwaway tip 1 of this embodiment is constructed as described above . An end mill 20 to which a plurality of throwaway tips 1 are mounted will now be described with reference to Figures 2 to 4 .

At the distal end of a tool body 21 of the end mill 20 , two concave grooves 22 and 23 are provided , which substantially oppose each other with respect to the rotation axis O defining the center of rotation and which are

cut out into substantially a fan-shape in cross section . The concave grooves 22 and 23 are formed by cutting out the tool body 21 from a longitudinal outer peripheral surface in the middle thereof toward a distal end surface 21a , a tip-mounting seat 24a is formed on a surface of one concave groove 22 facing a rotation direction , a tip-mounting seat 24b is formed on a surface of the other concave groove 23 facing the rotation direction .

To one tip-mounting seat 24a , the above-described throwaway tip 1 is mounted with the second long cutting edge 9 defined as a front cutting edge and projected from the distal end surface 21a of the tool body 21 toward the distal end , and this tip is referred to as a main tip 1A . To the other tip-mounting seat 24b , the throwaway tip 1 is mounted with the first short cutting edge 6 defined as a front cutting edge and projected from the distal end surface 21a of the tool body 21 toward the distal end , and this tip is referred to as a sub-tip 1B .

A state in which the first and second long cutting edges 8 and 9 are arranged in a direction to intersect the rotation axis O , as in the main tip 1A , is referred to as a lateral arrangement , and a state in which the first and second long cutting edges 8 and 9 are arranged in a direction along the rotation axis O , as in the sub-tip 1B ,

is referred to as a vertical arrangement .

In the main tip 1A , since the third corner cutting edge 12 is provided outside the distal end , the first short cutting edge 6 is provided so that it projects along the outer peripheral surface of the tool body 21 to be substantially in parallel with the rotation axis O , and is defined as an outer peripheral cutting edge , the second long cutting edge 9 projecting from the distal end surface 21a of the tool body 21 toward the distal end is inclined at an angle  $\alpha$  (for example ,  $\alpha = 5^\circ$  ) with respect to the line perpendicular to the rotation axis O so that it gradually comes close to the base end side from the outer periphery toward the rotation axis O , the second corner cutting edge 11 defining the acute angle of the other end of the second long cutting edge 9 is located on the opposite side of the rotation axis O , and the second short cutting edge 7 intersects the rotation axis O .

In the sub-tip 1B , since the first corner edge 10 is provided outside the distal end , the first long cutting edge 8 is provided so that it projects along the outer peripheral surface of the tool body 21 to be substantially in parallel with the rotation axis O and is defined as an outer peripheral cutting edge , the first short cutting edge 6 projecting from the distal end





angle is set to a negative angle .

Since the throwaway tip 1 and the end mill 20 according to this embodiment are constructed as described above, if a material to be cut is cut by rotating the tool body 21 around the rotation axis O, the corner cutting edges 12 and 10 on the outer periphery of the second long cutting edge 9 and the first cutting edge 6 projecting at the distal end of the tool body 21 bite into the material to be cut. Since this area is rotated at high speed as compared with an area near the rotation axis O, cutting resistance during biting is low and a cutting operation can be performed without causing chipping. Furthermore, by feeding the tool body 21 to an end of the rotation axis O, a rotary cutting operation can be performed like a drill with the second long cutting edge 9 and the first short cutting edge 6 whose rotation paths overlap.

By feeding the tool body 21 in the lateral direction , outer peripheral cutting can be performed with the first short cutting edge 6 and the first long cutting edge 8 defining the outer peripheral cutting edges , and a finish cutting operation can be performed with the corner cutting edges 12 and 10 of the second long cutting edge 9 and the first short cutting edge 6 .

Alternatively , a shoulder-cutting operation or a groove-processing operation can be performed with the first cutting edge 6 and the long cutting edge 8 defining the outer peripheral cutting edges .

Even if the cutting edges of one of the tips 1A and 1B are chipped or worn , the same throwaway tips 1 may be replaced and mounted .

As described above , according to this embodiment , a plurality of the same tips 1 can be mounted to the tool body with different mounting angles and in different postures so that the second long cutting edge 9 and the first short cutting edge 6 can be arranged as front cutting edges , and the short cutting edge 6 and the long cutting edge 8 can be arranged as outer peripheral cutting edges , and only one type of replacement tip need be stored . Therefore , the cost of manufacturing the tips and the running costs of the cutting tool can be reduced .

Moreover , since the corner angle of at least the first and third corner cutting edges 10 and 12 on both sides of the first short cutting edge 6 is set to  $90^{\circ}$  or less , for example , an acute angle , the corner cutting edges 10 and 12 at an outer-peripheral-side of the distal end of the main tip 1A and the sub-tip 1B can be provided in a state of being projected

greatest , and since the corner cutting edges 10 and 12 can be arranged as two cutting edges whose rotation paths overlaps with restricting the chipping of the corner cutting edges 10 and 12 , the cutting efficiency is high . In addition , the side faces 4 inside the main tip 1A and the sub-tip 1B are gradually inclined from the distal end of the tool body 21 toward the base end in the direction away from the rotation axis O . Therefore , the thickness of a center portion 26 of the distal end of the tool body 21 sandwiched by the tips 1A and 1B can be increased and ensured , and the rigidity of the tool body 21 can be secured .

A second embodiment of the present invention will now be described with reference to Figure 5 to 7 . The same or similar portions to those of the above-described first embodiment are indicated by the same reference numerals and a description thereof will be omitted . Figure 5 is a side view of a throwaway-type end mill according to the second embodiment .

Figure 6 is a side view of the end mill shown in Figure 5 , as viewed from the direction C , and Figure 7 is a side view of the same , as viewed from the direction D . A throwaway-type end mill 30 shown in Figures 5 to 7 according to the second embodiment has the same construction as the

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throwaway-type end mill 20 according to the above-described first embodiment . At the distal end of a tool body 21 , two concave grooves 31 and 32 are provided , which substantially oppose each other with respect to the rotation axis O defining the center of rotation and which are cut out into substantially a fan-shape in cross section . The concave grooves 31 and 32 have tip-mounting seats 24a and 24b formed on the distal end surfaces thereof facing a rotation direction , and a main tip 1A and a sub-tip 1B are attached thereto , respectively . The arrangement of the tips 1A and 1B is the same as the above-described first embodiment .

In one concave grooves 31 , a tip-mounting seat 31a is further formed at the base end side of the main tip 1A , and the above-described throwaway tip 1 is attached thereto as a third tip 1C . The third tip 1C is provided in such a manner that a second long cutting edge 9 is projected as an outer peripheral cutting edge from the outer peripheral surface of the tool body 21 to the outside in the radial direction so as to be located substantially in parallel with the rotation axis O , and a second short cutting edge 7 is directed to the distal end .

An axial rake angle of the second long cutting edge 9 is set to a positive

angle , as shown in Figure 6 , and the second long cutting edge 9 is shifted toward the base end from a first long cutting edge 8 defining an outer peripheral cutting edge of the sub-tip 1B that is located on the opposite position across the rotation axis O of the tool body 21 so that its rotation path overlaps the rotation path of the first long cutting edge 8 .

Moreover , the first short cutting edge 6 of the main tip 1A and the second long cutting edge 9 of the third tip 1C each defining an outer peripheral cutting edge are twisted rearward in the rotation direction of the tool body 21 from the distal end toward the base end .

In the other concave groove 32 , a tip-mounting seat 31b is further formed at the base end side of the sub-tip 1B , and the above-described throwaway tip 1 is attached thereto as a fourth tip 1D . The fourth tip 1D is provided in such a manner that the first long cutting edge 8 is projected as an outer peripheral cutting edge from the outer peripheral surface of the tool body 21 to the outside in the radial direction so as to be located substantially in parallel with the rotation axis O , and the first short cutting edge 6 is directed to the distal end .

An axial rake angle of the first long cutting edge 8 is set to a positive

angle , as shown in Figure 7, and the first long cutting edge 8 is shifted toward the base end from a second long cutting edge 9 defining an outer peripheral cutting edge of the third 1C that is located on the opposite position across the rotation axis O of the tool body 21 so that its rotation path overlaps the rotation path of the second long cutting edge 9 .

Moreover , the first long cutting edge 8 of the sub-tip 1B and the first long cutting edge 8 of the fourth tip 1D each defining an outer peripheral cutting edge are twisted rearward in the rotation direction of the tool body 21 from the distal end toward the base end .

According to the end mill 30 of the second embodiment , the main tip 1A located at the distal end of the tool body 21 is arranged in the vertical direction so that the first short cutting edge 6 defines an outer cutting edge , and the sub-tip 1B is arranged in the lateral direction so that the first long cutting edge 8 defines an outer peripheral cutting edge . Therefore , the third tip 1C and the fourth tip 1D can be arranged at the base end side of the main tip 1A and the sub-tip 1B so that the rotation paths of the outer peripheral cutting edges continue , and a deep hole processing can be performed . Moreover , this can be achieved by using the tips 1A, 1B , 1C

and 1D that are the same as one another .

The number of the tips 1 arranged is not necessarily four , and three or more than five tips may be arranged . Furthermore , in accordance with the arrangement of the main tip 1A in relation to the third tip 1C , since the first long cutting edge 8 located at the base end side of the main tip 1A is gradually inclined to the distal end from the outer periphery of the tool body 21 toward the rotation axis O , and the second short cutting edge 7 of the third tip 1C is inclined to the base end from the outer periphery toward the rotation axis O , the thickness of an outer peripheral portion 27 between the tips 1A and 1C can be increased from the outer periphery toward the inside . Therefore , the strength of the tool body 21 can be secured together with the strength of a center portion 26 of the distal end thereof .

In Figure 5 to 7 , one or both of the third tip 1C may be arranged in the lateral direction ,and the first short cutting edge 6 and /or the second short cutting edge 7 may be defined as outer peripheral edges .

Alternatively , the third tip 1C and the fourth tip 1D may be turned upside down and arranged in the vertical direction , and the first long cutting edge 8 and the second long cutting edge 9 may be defined as outer peripheral



cutting edges . In short , the tips may be arranged either in the vertical direction or in the lateral direction as long as they can be arranged so that the rotation paths of the peripheral cutting edges overlap .

Another example of the throwaway tip of the present invention will now be described as a third embodiment . The same or similar portions to those of the throwaway tip 1 according to the first embodiment will be described using the same reference numerals .

Figure 8 ( a ) is a plan view of a throwaway tip according to this embodiment , Figure 8 ( b ) is a side view of the throwaway tip shown in Figure 8 ( a ) , as seen from the direction E . Figure 8 ( c ) is a side view of the same , as seen from the direction F , and Figure 8 ( d ) is a side view of the same , as seen from the direction G .

A throwaway tip ( hereinafter , it may be referred to as tip ) 40 shown in Figure 8 according to the third embodiment is formed in substantially the shape of a rectangular plate , an upper surface 41 which opposes a lower surface 2 defining a seating surface is formed in a planar shape which is inclined from a first short cutting edge 6 toward an opposing second short cutting edge 7 so that the distance between the upper surface 41 and the



short cutting edge 6 is located at the distal end , as shown in Figure 11 ,

an axial rake angle of a first long cutting edge 8 serving as an peripheral

cutting edge can be increased , and the cutting quality in the outer

peripheral cutting can be improved .

In mounting the tip 1 according to the first embodiment and the tip 40 according to the third embodiment to an end mill , the arrangement of the tips 1 and 40 is not limited to one form in which the main tips 1A and 40A are arranged in the lateral direction at the distal end of the tool body 21 and the sub-tips 1B and 40B are arranged in the vertical direction , as shown in the end mill 20 and 30 of the first and second embodiments , and other suitable arrangement forms may be adopted .

For example , in Figure 12 ( a ) , if two tips 1 and 1 ( 40 and 40 ) are arranged in the lateral direction to define first short cutting edges 6 and 6 as outer peripheral cutting edges and define second long cutting edges 9 and 9 as front cutting edges , this arrangement form can be adopted to a tool body 21 having a large outer diameter . An end mill 50 can be applied to a large-diameter-hole drilling operation . In an end mill 60 shown in Figure 12 ( b ) , one tip 1 is arranged in the lateral direction to define a first





cutting edge 7 , a first long cutting edge 8 , and a second long cutting edge 9 are linear-shaped cutting edges inclined at an arbitrary angle so that the distance between the lower surface 2 and these cutting edges gradually changes from one end of each of the corner cutting edges toward the other end . An insertion hole 5 passing through the upper and lower surfaces 44 and 2 is formed in a direction to intersect nearly perpendicularly to the lower surface 2 . The insertion hole may be made to intersect perpendicularly to the upper surface 44 .

The adoption of such a construction can set a suitable radial rake angle and an axial rake angle according to the mounting position or the posture of each cutting edge .

Breaker grooves may be formed in the upper surfaces 3 , 41 , 44 .

The front cutting edges of the two tips 1 and 1 ( 40 and 40, 43 and 43 ) may be provided at a position above the center of rotation of the tool body or at a position below the center of rotation of the tool body .

In the tips 1 , 40 , 44 of the third embodiments , the corner angles of the first and third corner cutting edges 10 , 11 , and 12 may be either equal or unequal to one another .

While the long cutting edges 8 and 9 and the short cutting edges 6 and 7 in the throwaway tips of the above-described first and third embodiments and the modification are straight-lined cutting edges , they may be instead convexly curved cutting edges or concavely curved cutting edges , In this case , the upper surfaces 41 and 44 may be convex surfaces or concave surfaces .

The throwaway tip according to the present invention may be mounted to various types of cutting tools, such as other types of rolling tools or turning tools without being limited to the end mills 30 ,50 , 60 , 70 , 80 , and 90 .

[ 4th embodiment ] The 4 th embodiment in this invention is explained in Figure 14 and Figure 15 . The explanation is omitted using the same marks in a same or similar portions to those of above mentioned 2nd embodiment . Figure 14 is a plane view of the throwaway tip according to the 4th embodiment, Figure 15 is side view of an end mill of throwaway type according to the 4th embodiment . Throwaway tip 96 shown in Figure 14 is the one that the sub-cutting tooth 97 is formed with the inclination to the other portions so that it may retreat inside the field 3 of 1

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long tooth 9 of tip 96A is projected to the tip side of the main part 21 of a tool rather than other portions of the second long tooth 9 . Moreover , the second long tooth 9 of a tip 96B is located in the inner circumference side of the main part 21 of a tool , and don't act on cutting . And the tip attachment seat 31a is further formed in the base edge side of main tip 96A in the other concave groove 31 , and the throwaway tip 96 mentioned above is equipped as the third tip 96C . This third tip 96C is projected to the out side of radius direction from the perimeter face of the main part 21 of the tool as the perimeter tooth of the second long tooth 9 , and is located almost parallel to the rotation axis O , and is set toward the second short tooth 7 in a tip side . In this attachment construction , the sub-cutting tooth 97 formed in a third tip 96C has escaped to the inner circumference side of a main part 21 of a tool to other portions of the second long tooth 9 . Next , tip attachment seat 31b is also formed in a base side of sub-tip 96B in the other concave groove 32 , and the throwaway tip 96 mentioned above is set as the fourth tip 96D . This fourth tip 96D is projected to outer side of radius direction from the main part 21 of a tool as the perimeter tooth of the first long tooth 8 , and is located almost parallel to the rotation

axis O , and is set toward the first short tooth 6 in the tip side .

In this construction , the second long tooth 9 of a tip 96D is located in the inner circumference side of a main part 21 of a tool , don't act on cutting .

According to end mill 98 by this fourth embodiment, the sub-cutting tooth 97 of a tip 96A can be used in a finish cutting in a throwaway tip 96, and the sub-cutting tooth 97 in a tip 96B, 96C, 96D don't act on a cutting of work material. Thus, in end mill 98, since the advance of the wear of sub cutting tooth 97 is prevented except the use of the second long tooth 9 as front face tooth, the throwaway tip 96 can secure the sharpness of the sub-cutting tooth 97, and when it uses the sub-cutting tooth 97 as a front face tooth and performs finish machining of a work material, it can acquire a good finished surface. Moreover, in tip 96D located in the most base edge side of a main part 21 of a tool, since the first long tooth 8 which is not formed sub-cutting tooth 97 as a perimeter tooth is used, it can be possible to hold the maximum cutting of depth S of throwaway type cutting tool, forming sub-cutting tooth 97 in the second long tooth 9.

In addition , the arrangement number of sheets of a tip 96 is not necessarily four sheets , three sheets or more than five sheets may be set .

Moreover , in the fourth embodiment mentioned above , although the throwaway tip 96 shall consist of having formed the sub-cutting tooth 97 in the second long tooth 9 in a throwaway tip 1 by the first embodiment shown in Figure 1 , not only limiting in this , it may consist of forming the sub-cutting tooth 97 in the second long tooth 9 in a throwaway tip 40 or 43 . Moreover , you may equip not only end mill 98 but also other end mill with the throwaway tip 96 .

[ 5 th embodiment ] although the throwaway tip and throwaway type end mill by the 5 th embodiment of this invention are explained with the reference to a drawings , the explanation is omitted by using the same marks in a portion of the same or similar parts to each embodiment mentioned above . Figure 16 and Figure 17 show the throwaway tip by the 5 th embodiment , and Figure 18 to Figure 20 show the throwaway type end mill by the 5 th embodiment . Figure 16 is a plan view of a throwaway tip , and Figure 17 is a cross-sectional view of each part of the throwaway tip shown in Figure 16 . (a) is L-L line cross-sectional view in Figure 16 , (b) is M-M line cross-sectional view in Figure 16 . Figure 18 is a principal part side view of end mill which equipped with the throwaway tip shown in

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Figure 16 , and Figure 19 is a front view of end mill shown in Figure 18 ,  
Figure 20 a principal part side view which looked at the end mill shown in  
Figure 18 from the perimeter tooth side . The throwaway tip ( it may be  
hereafter called a tip ) 101 by the embodiment shown in Figure 16 and  
Figure 17 is made into the shape of an approximately square plate like  
by which the arrangement and form of the under face 2 , upper face , the  
four side face 4, insert hole 5 are made almost the same as the throwaway  
tip 1 by 1st embodiment . Moreover , in four edge side on a upper face 3  
of a tip 101, a each pair of edge side which opposite each other , is made a  
short tooth and long tooth same as tip 1 , one side of the cutting tooth of two  
tooth which constitutes a short tooth is taken as the first short tooth 6  
which it is comparatively long , the other is made the second short tooth 7  
which is comparatively short . The two side which opposite to the other  
which constitute the long tooth is made the first long tooth 8 and the second  
long tooth 9 which is longer than the first short tooth 6 . And the first  
short tooth 6 and the second short tooth 7 which opposite each other is made  
non-parallel , and the first long tooth 8 and the second long tooth 9 which  
opposite each other is also made non-parallel . The upper face 3 is made





20 by the first embodiment , the throwaway tip 101 by this embodiment is equipped on tip attachment seat 24a ,24b formed in a tip part of a main part 21 of a tool . And , the throwaway tip 101 mentioned above is equipped at one tip attachment seat 24 a of the main part 21 of a tool .

The second long tooth 9 is projected to a tip side from the tip face 21a of a main part 21 of a tool as the front face .This tip is as 101A . In other tip attachment seat 24b , the throwaway tip 101 is equipped projecting the first short tooth 6 from the tip face 21a of a main part 21 of a tool as the front face tooth . This is as sub- tip 101B . ( the arrangement of the main tip 101A and sub-tip 101B in end mill 20a by this embodiment is almost made same as the main tip 1A and sub-tip 1B in end mill 20 by the first embodiment shown in Figure 18 to Figure 20 .)

With such arrangement construction , the strengthening part 15 of the second long tooth 9 which is a front face tooth of a main tip 101 A is located in a circumference side in a front face tooth . Moreover , the strengthening part 15 of the first long tooth 8 which is perimeter tooth of sub-tip 101B is located in a base edge side of a tool in a perimeter tooth .

Since the throwaway tip 101 and end mill 20a in this embodiment is

constructed as mentioned above , it can be possible to cut the work material like the throwaway tip 1 and end mill 20 by the first embodiment .

And , what is necessary to exchange the same throwaway tip 101 and just equip , even if the cutting tooth of one of the tips 101A and 101B is suffered a loss or worn out . Here , in conventional end mill , it is formed the overlapping part of rotation locus of perimeter tooth of two tips (the part becoming two number of tooth ) and not overlapping part ( the part becoming single tooth ) in perimeter tooth of each throwaway tip when a main part of tool is rotated in a rotating axis line . And compared with the portion used as a two sheet edge , it is easy to damage the portion which serves as a single edge in a cutting tooth in response to strong cutting resistance at the time of cutting of work material .

In end mill 20a of this embodiment, in each cutting work, the first long tooth 8 which is perimeter tooth of sub-tip 101B is not overlap the locus of the first short tooth 6 which is perimeter tooth of main tip 101A, this portion will cut the work material as a single tooth.

And in portions other than this , although the perimeter tooth of both tips will cut the work materials as a two sheet edge , in these both tips , the



strengthening part 15 is formed in a part of single edge , and is secured the strength of the cutting tooth of this portion . And in both tips , the selection of the shape of cutting tooth is not necessary in other portion , and it can be possible to decrease the drop of the sharpness by taking the shape of cutting tooth which the sharpness of cutting tooth is thought as important in this portion . According to throwaway tip 101 and end mill 20a which is constituted as this , in perimeter tooth of each tip 101 , the strengthening part 15 is set in a portion of single tooth , as the results, the strength of cutting tooth is secured , and it is possible to do the shape of cutting tooth where the sharpness was thought as important in a portion of two cutting tooth , you may be possible to secure the strength of cutting tooth and to decrease the drop of the sharpness in a throwaway tip .

[ the 6 th embodiment ] Although the 6 th embodiment of this invention is explained by Figure 21 to Figure 23 , the explanation is omitted using the same marks in a same or similar portion with each embodiments mentioned above . Figure 21 is a side view of an throwaway type end mill by the 6 th embodiment , Figure 22 is a C2 direction side view of the end mill shown in Figure 21, Figure 23 is also C2 direction side views .





Sub C1

[illegible]

And in perimeter tooth of each tip , the other portion will cut the work material as a two sheet tooth .

Here , in each tip , the strengthening portion is formed in the portion used as single tooth , and the strength of this portion is secured . And since other portions do not need to add restriction to cutting tooth shape in each tip , a fall of sharpness can be reduced as cutting tooth shape where sharpness was thought as important .



7 , and therefore, the first long tooth 8 and the second long tooth 9 become linear like tooth from the first short tooth 6 toward the second short tooth 7 . Therefore , in the second short tooth 7, the distance with the under face 2 is formed to the smallest . Moreover , the penetrated hole 5 which penetrates the vertical sides 2 and 41 is punched in the direction which carries out an almost rectangular cross on the under face 2 . Or you may it intersect perpendicularly with the upper face 41 . Properly , the strengthening portion 15 is constructed in a 4th corner tooth 13 slippage of the first long tooth 8 and a 2nd corner tooth 11 slippage of the second long tooth 9 in this throwaway tip 102 . In case that this throwaway tip 102 is equipped in an end mill 30a(20) mentioned above in place of tip 101, if it is equipped not changing the radial rake angle and axial rake angle of each tooth of each tip 102 , it can be possible to enlarge the thickness of tip attaching seat 24a ,24b, 31a, 32a, of the back face of tip , and the strength of tooth of a main part 21 of a tool can be improved .

In main tip 102A shown in Figure 25 and the third tip 102C shown in Figure 26 , the thickness of the second short tooth 7 side of tip attaching seat 24a, 31a can be thickened . Moreover , in case that it is equipped



penetrate the vertical face 2, 44 is punched in a direction of approximately rectangular cross on the under face 2 . Or you may make it intersect perpendicularly with the upper face 44 . If such composition is adopted , according to the attachment position and style of each cutting tooth , a suitable radial rake angle and a axial rake angle can be set up .

In addition , you may establish a breaker slot in the upper face 3, 41, 44 .

Moreover , the each front face tooth of two sheets of tip 101, 101 ( 102, 102 ; 103, 103 ) may be arranged in the position of core going up or core going down . Moreover , in a tip 101, 102 , 103 by the 5 th and the 7 th embodiment , the corner angle of the 1 st and three corner tooth 10 , 11, 12 of an acute angle is the same or may not be the same . In addition , in each throwaway tip 101, 102, 103 by the 5 th and the 7 th embodiment , and modification , each long tooth 8, 9 ,short tooth 6 , 7 made into straight like , in replace of this , convex curved like or concave curved like may be good also, in this case , the upper face 41, 44 may be sufficient as a convex curved face or concave curved face . Moreover , various cutting tools such as other kind of milling tool , cutting tool by lathe can also be equipped with the throwaway tip by this invention without being limited to end mill 30a .



[ the 8th embodiment ]      The 8 th embodiment in this invention is explained by using Figure 29 and Figure 30 , the explanation is omitted by using the same mark in same or similar portion with the 6 th embodiment mentioned above .      Figure 29 is a plan view of the throwaway tip by the 8 th embodiment, Figure 30 is the side view of throwaway type end mill by the 8 th embodiment .      In the throwaway tip 101 by the 5 th embodiment shown in Figure 16 , the throwaway tip 104 shown in Figure 29 is the one that the sub-cutting tooth 97 which inclines so as to retreat inside of the face 3 of 1 as it approaches the third corner tooth 12 is formed in a edge portion including the third corner tooth 12 of the second long tooth 9 .      The sub-cutting tooth 97 inclines at the angle  $\theta$  ( for example ,  $\theta=5^{\circ}$  ) to the other portion of the second long tooth 9 .      The throwaway type end mill 98a by the 8 th embodiment is the same composition with the throwaway type end mill 30a by the 6 th embodiment mentioned above , the tip 104 is arranged in replace of tip 101 .      In a tip portion of a main part 21 of a tool, two concave grooves 31, 32 which is cut in approximately fan shape of cross-section opposite to rotation axis O which makes the rotation center .      The tip attachment seat 24a , 24b is formed in the face of rotation direction





tool , since the first long tooth 8 not forming the sub-cutting tooth 97 is used as a perimeter tooth , the maximum depth of cut S of throwaway type cutting tool can be secured , forming sub-cutting tooth 97 in second long tooth 9 . In addition , the arrangement number of sheets is not necessarily four sheets , you may arrange three or more than five sheets . Moreover , in the 8 th embodiment mentioned above , the sub-cutting tooth 97 is constructed to the second long tooth 9 in throwaway tip 101 by the 5 th embodiment shown in Figure 16 , however, for example , the sub-cutting tooth 97 is formed to the second long tooth 9 in either not only of this but the throwaway tip 102 or 103 . Moreover, the throwaway tip 104 may be not only equipped with end mill 98a but also other end mill .

[ the 9th embodiment ] the 9 th embodiment of the throwaway tip in this invention as another example is shown in Figure 31 , it is explained by using the same mark in a same or similar portion with the throwaway tip 101 by the 5 th embodiment . Figure 31 is a sectional view showing the cross-sectioned form of each portion of throwaway tip in this embodiment , ( a ) is a sectional view corresponding to L-L line sectioned view of throwaway tip by the 5 th embodiment , ( b ) is a sectional view corresponding to M-M

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line sectioned view of throwaway tip by the 5 th embodiment . The throwaway tip 105 ( hereinafter, may be called as a tip ) by the 9 th embodiment shown in Figure 31 has an almost same shape with that of the throwaway tip 101 shown in Figure 16, the circle honing is given in each cutting tooth . And it differs to the throwaway tip 101 , the strengthening portion 15 of the first and second long tooth 8, 9 is not made as small the rake angle to other portion , made as the following compositions .

Namely , the strengthening portion 15 of first long tooth 8 is constructed as follows , as shown in a section view of Figure 31 , the curvature radius R1 of the tip of tooth portion of second corner tooth 11 slippage in the first long tooth 8 is made larger than that R2 of the other portion of the first long tooth 8 ( refer to Figure 31 ( b ) ) . Similarly , the strengthening portion 15 in the second long tooth 9 is also constructed so that the curvature radius of a tip of tooth of the 4 th corner tooth slippage R1 is made larger than that R2 of other portion of the 1 st long tooth 8 ( not shown in figure ) . The strengthening portion 15 is taking the curvature radius of the tip of the tooth larger than other portions , raises the cutting strength of this portion.

Here , the curvature radius R1 of the strengthening portion 15 comrades

or the curvature radius R2 of other than strengthening portion 15 is good also as the same with the first long tooth 8 and the second long tooth 9 , and it can also consider as a curvature radius different , respectively .

[ the 10th embodiment ]      The 10th embodiment of the throwaway tip in this invention as another example is shown in Figure 32 , it is explained by using the same mark about the same or similar portion with the throwaway tip 101 by the 5th embodiment .      Figure 32 is a sectional view showing the cross-sectioned form of each portion of throwaway tip in this embodiment , ( a ) is a sectional view corresponding to L-L line sectioned view of the throwaway tip by 5 th embodiment , ( b ) is a sectional view corresponding to M-M line sectioned view of the throwaway tip by the 5 th embodiment .      The throwaway tip 106 ( hereinafter may be called as a tip ) by the 10 th embodiment shown in Figure 32 is the almost same as that of the throwaway tip 101 shown in Figure 16 .      And it differs in the throwaway tip 101 , the strengthening portion 15 of the 1 st , 2 nd long tooth 8, 9 is not made the rake angle to the other portion small, but considers as the as the compositions which is described below .      Namely , as shown in a sectional view of Figure 32 ( a ) , the width W1 of land portion 14 of the 2

